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The common control and display standards initiative shall define the process to achieve commonality among USW platforms. The progression of display commonality will be presented, as well as the relationship of common Navy operator tasks.

The standard approach to controls and displays will allow the operator to more rapidly assimilate large data sets, possess a common frame of reference for operator tasks, and potentially reduce cross training. The consistent and predictable actuation of controls and navigation of displays will allow for common situation assessment across the combat system teams. This methodology for control and display commonality will be shown to support the network-centric warfare vision.

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# Display And Control Commonality Initiative Among Undersea Warfare Sonar Systems

## ABSTRACT

Sonar Systems in the Undersea Warfare (USW) environment have similar tasks and functions across platforms in a multi-dimensional battlespace. The Operator-Machine Interface (OMI) Commonality Working Group (OCWG), as chartered by the USW Executive Steering Group (ESG), has authored a control and display standards and conventions document for sonar systems in the Surface, Subsurface, and Surveillance Communities. These standards present a framework for a common "look and feel" to all operator interface controls and displays, such that operators trained in one aspect of USW sonar systems may easily adapt to operation of other USW sonar functions.

The common controls and displays standards initiative, as presented in this paper, shall define the process to achieve commonality among Undersea Warfare platforms. The progression of display commonality standards will be presented, as well as the relationship of common Navy operator tasks. This paper will report on the efforts to date of the OCWG and characterize the resulting standards document.

The standard approach to controls and displays will allow the operator to more rapidly assimilate large data sets, possess a common frame of reference for operator tasks, and potentially reduce cross training. The consistent and predictable actuation of controls, as well as the navigation of displays, will allow for common situation assessment across the combat system teams. This methodology for control and display commonality will be shown to support and enhance the network-centric warfare vision.

## INTRODUCTION

### Background

The Operator-Machine Interface (OMI) Commonality Working Group (OCWG) was established by direction of the Undersea Warfare Executive Steering Group (USW ESG) in August 1996. PEO USW chairs the ESG, with co-chairs including naval captains from the Subsurface, Surface, and Surveillance communities. This effort brings together individuals from major United States Navy Undersea Warfare Sonar System Programs to define and generate a set of commonality standards and conventions which can be applied to existing and future Navy USW program developments. Due to shrinking budgets, merging of the Sonar Technician Surface (STG) and Ocean Systems Technician (OTA) ratings, and the increased use of Commercial Off-The-Shelf (COTS) technology, there was a realization that a common "look and feel" for USW sonar displays across different surface, subsurface, and surveillance programs is required. Furthermore, the need for commonality is exasperated by the Navy's overall initiative to have fewer operators perform more functions.

### Purpose

This paper describes the common control and display standards initiative process to achieve commonality among Sonar Systems in Undersea Warfare (USW) platforms. The progression of display commonality standards is being presented here, as well as the relationship of common Navy operator tasks.

In the current acquisition environment for Navy systems, there is more emphasis on leveraging and sharing tactical products. In addition, as the integrated battle-group concept becomes reality, the potential for sharing information in a real-time environment across platforms arises. In the previous Navy development environment, the surveillance, subsurface, and surface communities conducted independent development of their tactical systems. This resulted in unique terminology, non-standard methods for displaying the same data types, and varying control methodologies. This paper reports the efforts to date of the OCWG and characterizes the resulting standards document.

## Participants

The OCWG is comprised of representatives from program offices in the various undersea warfare communities. These offices include Program Directorate for Intelligence, Surveillance, and Reconnaissance (PD-18), Program Manager Ship for Submarines (PMS401, 425, and 450), and Program Manager Ship for Surface Ships (PMS-411). Membership included representatives of these naval communities in the form of active duty enlisted military, civil servant, contractor, and academia personnel. This wide variety of background, mission, and knowledge base provided the OCWG with thorough insight into the USW operator's task requirements.

The OCWG was established in August 1996 and meets on a periodic basis. The OCWG emphasizes working together, sharing technology, and promoting commonality within the USW communities. There are currently numerous multi-program commonality efforts underway, and the products of the OCWG will be integral to achieving the overall goals of all these efforts.

## Individual Products

The USW communities represented in the OCWG brought prior operability experience to the group through their various OMI documents and evaluations conducted for their individual communities. The Surface Ship community developed an OMI Styleguide for their SQQ-89 program. Through several OMI demonstration prototypes, where new operator interfaces were presented to and evaluated by fleet representatives, this Styleguide evolved into the SQQ-89 (V) 14 Standards and Conventions (S&C) document. The Surface Ship S&C document was based heavily on the S&C developed for the New Attack Submarine program or the Virginia Class Submarine (formerly referred to as the NSSN). The submarine community saw the necessity for a document to guide the individual OMI design, development, and implementation of its fifteen federated subsystems that comprise the Command, Control, Communications, and Intelligence (C3I) combat system. The NSSN S&C was based in part on the AN/BSY-2 S&C document first developed for the Seawolf Class integrated submarine combat system. This program has employed for the first time in a submarine combat system the use of such operator interface devices as the trackball, infrared touch panels, color displays, and software driven controls replacing previous mechanical interfaces.

The Surveillance community also had a standards document known as the Integrated Undersea Surveillance System (IUSS) Operator-Machine Interface Commonality Standards. Again, their USW system was comprised of several independent functions, and this standard was an effort to structure the individual operator interfaces to be more common.

All three USW communities' documents were based on a joint military styleguide originally known as the Navy Command and Control Systems (NCCS) Guide that was first developed in 1992. This guide's

purpose was to standardize operator interfaces across all military systems in the joint forces (Army, Navy, and Air Force). This document has progressed over the years into the Joint Maritime Command Information Systems (JMCIS) Guide in 1993, to the Global Command and Control System (GCCS) Guide in 1994 and currently to the User Interface Specifications for the Defense Information Infrastructure (DII) Styleguide. The DII is currently in its third revision and is prepared for the Joint Interoperability and Engineering Organization of the Defense Information Systems Agency (DISA).

However, the DII addresses very high level requirements and OMI aspects, thus is not tailored to USW
Sonar System applications. This leaves many questions unanswered by USW system developers, which drives the need for a more specific OMI document, such as the USW Sonar Systems S&C.

Figure 1 depicts the individual USW communities' OMI documentation evolution and the eventual evolution into a Standards and Conventions document for USW Sonar Systems Controls and Displays.

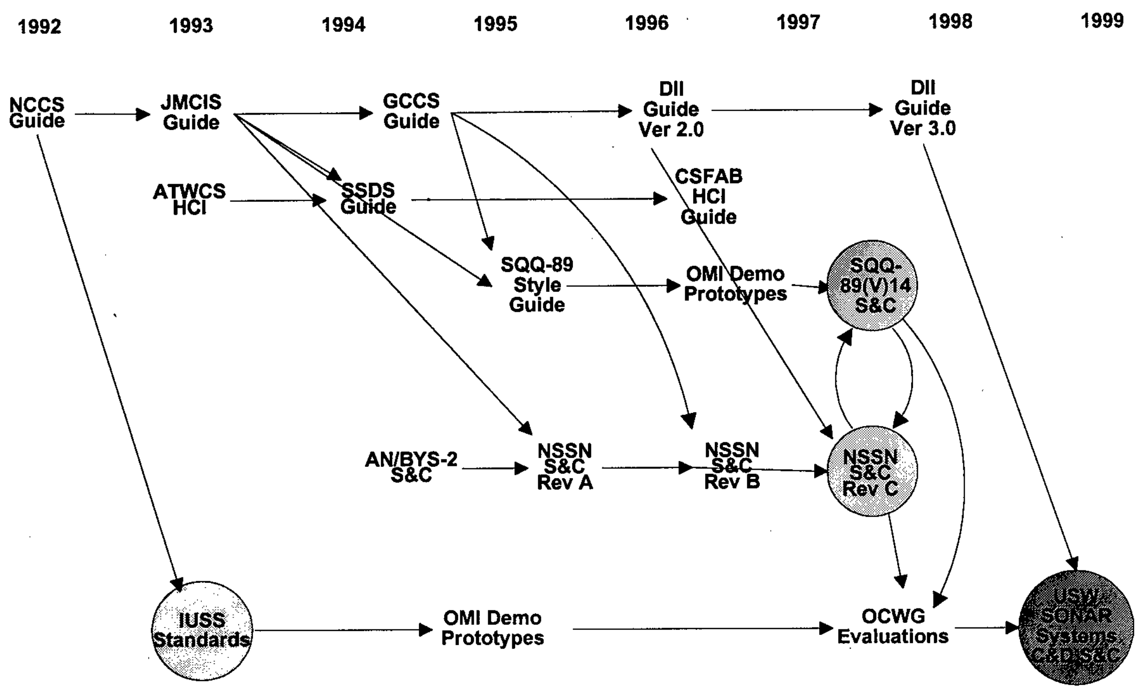


**Figure 1. USW S&C Document Evolution**

## Consolidation Process

Through the mechanism of the OCWG, it was uncovered that the USW operator in any of the three communities (Surface Ship, Submarines, or Surveillance) has several common tasks with common requirements. Some of these common tasks included: displaying, manipulating, and interrogating sonar data; tagging, tracking, and classifying individual data points of interest; and logging, analyzing, and operating on these individual points. Once the common tasks and requirements were known, the group began to expatiate on the subject and arrive at a set of common operator tools to perform the necessary tasks.

Some of the common operator interface tools arrived at included: standard definitions and terminology; common cursors to interrogate sonar data; standard style and presentation of controls; standard navigation through controls; and common usage of color throughout the operator interface. It was determined that common terminology plays a large role in achieving commonality across USW operator's tasks. Something as simple as a passive narrowband gram of data had different meanings to the different communities. Therefore, a very specific definition resulted through compromise by the various current and former sonar operators in the OCWG. For the general USW operator, a Passive Narrowband gram "plots passive acoustic energy in a frequency versus time presentation across a set frequency region or in specific frequency bands, at a set resolution and integration rate. The background processing for this display emphasizes narrowband signatures. Narrowband processing tuning, using various normalizers, may be used to focus on wide band energy and transient type data." A sizeable list of common terms and definitions was arrived at and adopted by the OCWG as a first step to outlining the common requirements of USW operators across communities.

An even more important aspect of commonality was determined to be the standard style/presentation and navigation of controls, that is the "look and feel" of a display format. The style and presentation of operator controls are determined by the control type, characteristics, and color/dimensionality. In commercial personal computer applications, it has been demonstrated to be more operable and to promote display commonality to have all operator controls in the same color scheme with the same borders providing a three-dimensional (3D) or similar effect which denotes a control, as opposed to a data area.

A characteristic of a control is its reaction upon selection. All controls of the same type should react in the same manner when selected. Expected behavior is critical to an operator in a high intensity situation where there is not always enough time to contemplate a control's response. A control's response should be intuitive and predictable to a degree that an operator is comfortable with its reaction. Some examples of the more common types of controls are push buttons, pull down menus, and scroll or slide bars. Push buttons can be momentary, providing feedback upon selection that an action has been taken, such as a highlighted border. Push buttons can be toggle controls providing knowledge of which state a display aspect will change to upon selection. Push buttons can also indicate status by filling in an accompanying icon, which through various groupings of controls, can indicate multiple conditions actuated simultaneously, as in the check box control, or mutual exclusive conditions, as indicated by the radio control. It should be noted that every effort was made to utilize standard commercial control types to minimize unique software requirements. Figures 2 and 3 show examples of the radio button control and the check box control, respectively.

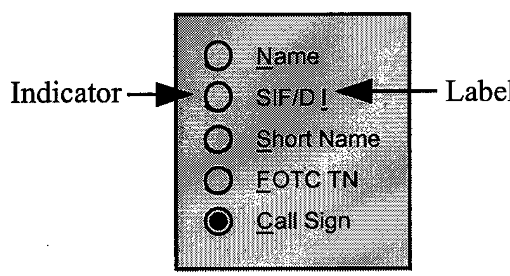


**Figure 2. Example Radio Button Control**

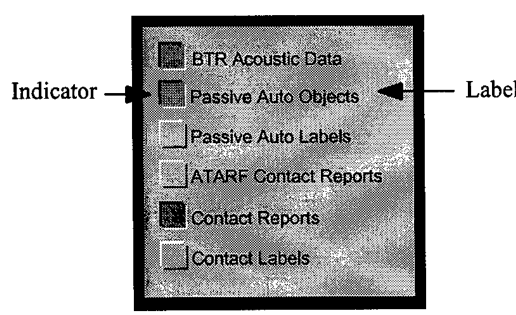


**Figure 3. Example Check Box Control**

Scroll bars and slider bars are other types of controls that allow more dimensions of parameters to be changed simultaneously. By a sliding action, parameters may be modified in small steps or in large increments by simply exaggerating the motion upon selection. Figure 4 provides an example of a scroll bar control mechanism.

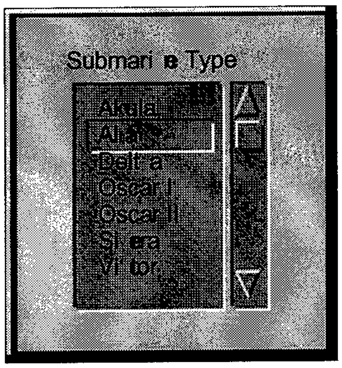


**Figure 4. Example Scroll Bar Control**

Control navigation entails the operator's ability to easily locate, manipulate, and select certain controls needed to perform certain tasks at any given time. Navigation through controls is another important aspect to commonality in the area of operator task performance. If an operator is familiar with the steps required to perform one task, then is it easier to learn a new yet similar task. Plus, the operator can quickly and efficiently navigate through the controls of a particular task if they are intuitive and easy to manipulate, thus applying more attention to the intended task. More direct actuation of controls is preferred, that is, a shorter path to frequently used controls or implementation of "fast path" controls that can be made available at all times. All these aspects make up control navigation.

## Evaluation Process

The OCWG began to formulate a set of common display and control characteristics by collating the individual OMI standards from the various communities into a prototype display that could then be evaluated by actual sonar operators and supervisors. Three evaluations were conducted in a phased approach over a one-year period. The evaluations utilized a total of 410 evaluation reports from fleet operators to exercise and critique the proposed designs. They were conducted across the country at naval facilities in Norfolk, VA; Groton, CT; San Diego, CA; and Whidbey Island, WA; to insure ample representation by surface ship, submarine, and surveillance communities with varying levels of experience.

Evaluations in three phases were conducted through use of prototyped controls and displays developed using UIM/X, a rapid prototype Graphical User Interface (GUI) builder, which incorporated the most recent MOTIF user interface designs. TAC-3 and TAC-4 computers were used to host the evaluation software. The fidelity of the prototyped software contained only enough of the display components required to adequately represent the OMI "look and feel" techniques of interest and was not meant to emulate any of the aforementioned tactical systems.

Starting from a clean slate for a common control and display design was not practical for USW systems. There were two IUSS systems (SURTASS and SSIPS) already fielded, plus the submarine system (Acoustic-Rapid Commercial Off-The-Shelf Insertion or ARCI) and the surface ship's AN/SQQ-89 (V) 14 were well down the development path. Therefore, the first evaluation held was very rudimentary and utilized representative acoustic controls and displays from each of these four systems. This Phase 1 Evaluation successfully identified a common approach to OMI between otherwise dissimilar displays intended for similar purposes—acoustics. Many of the evaluated components could be located in consistent places, formatted in consistent ways, labeled with the same name, or ranked in the same order without compromising system specific functionality. Validation of this approach and developing a common acoustic template was the next

step. A common template would allow developers to incorporate their specialized functions into an established display design saving them time in the development cycle by already having resolved many of the control and display design issues.

The Phase 2 Evaluation continued the design verification process by having operators assess more specific OMI tools such as: a system menu bar and control options; cursor readouts; alert notification and management; own ship/sensor readouts; and an overall common template. Phase 1 had anonymously presented display components from the four existing USW sonar systems, whereas Phase 2 was designed to identify the optimum location, layout, size, behavior and other characteristics of some specific OMI components. A more generic display template was utilized for each community, as opposed to a format from the existing USW sonar systems. The desire to converge on a single common display template drove the need for a Phase 3 Evaluation.

Phase 3 began with the development of a single display template prototype that incorporated the results from Phases 1 and 2. Operator comments that the readout information and sensor types where not relevant to a particular USW community prompted a decision to tailor the common template to each community. This action decreased the bias introduced by data readouts not normally encountered in all USW sonar communities. Thus, each community evaluated a version of the display template relative to their sonar system. In every other respect, the prototypes were identical. This phase of the evaluations focused on the common template's compatibility for use in each community's sonar system. Evaluators were asked to assess whether the layout, location, and relative prominence of data elements would support their operational requirements.

In each phase of the evaluations, a questionnaire was developed by the OCWG members to be used in conjunction with the prototype software. These questionnaires were designed to elicit answers on which OMI methods and tools were most effective in a given situation and to gain the operator's feedback on specific display template components. This method of questioning was designed to steer the evaluators toward selecting effective OMI rather than personal preferences. The scope of this effort did not permit experimental data collection in support of a more objective evaluation process. As such, significant portions of the findings are based on subjective inputs from the fleet users.

During the Phase 2 Evaluation, when the evaluators were asked to choose out of seven different control types which would they prefer to use depending on how frequently an operation was performed, the following interesting results were concluded. For "continuously" performed functions the control type order of preference was hotkeys or function keys (25%), followed by push buttons with symbol labels (24%), and push buttons with abbreviation or text labels (18%). Whereas for inherently dangerous functions that could cause loss of or damage to personnel, equipment or systems during operations, 26% of those evaluated chose the pull-down menu type of control.

Pull-down menus were decidedly preferred for rarely used or dangerous functions. Preferences in frequency of use order for pull-down menus were for rarely performed (33%), infrequently performed (31%), and dangerous to personnel or systems (26%).

An option menu is a type of pull down menu that has one of the options as its menu title to provide the state that the control is currently in. Normal pull-down menus have a title that the operator sees which is not one of the selectable options. The options are not visible until the control is pulled down. For option menus, the evaluators'

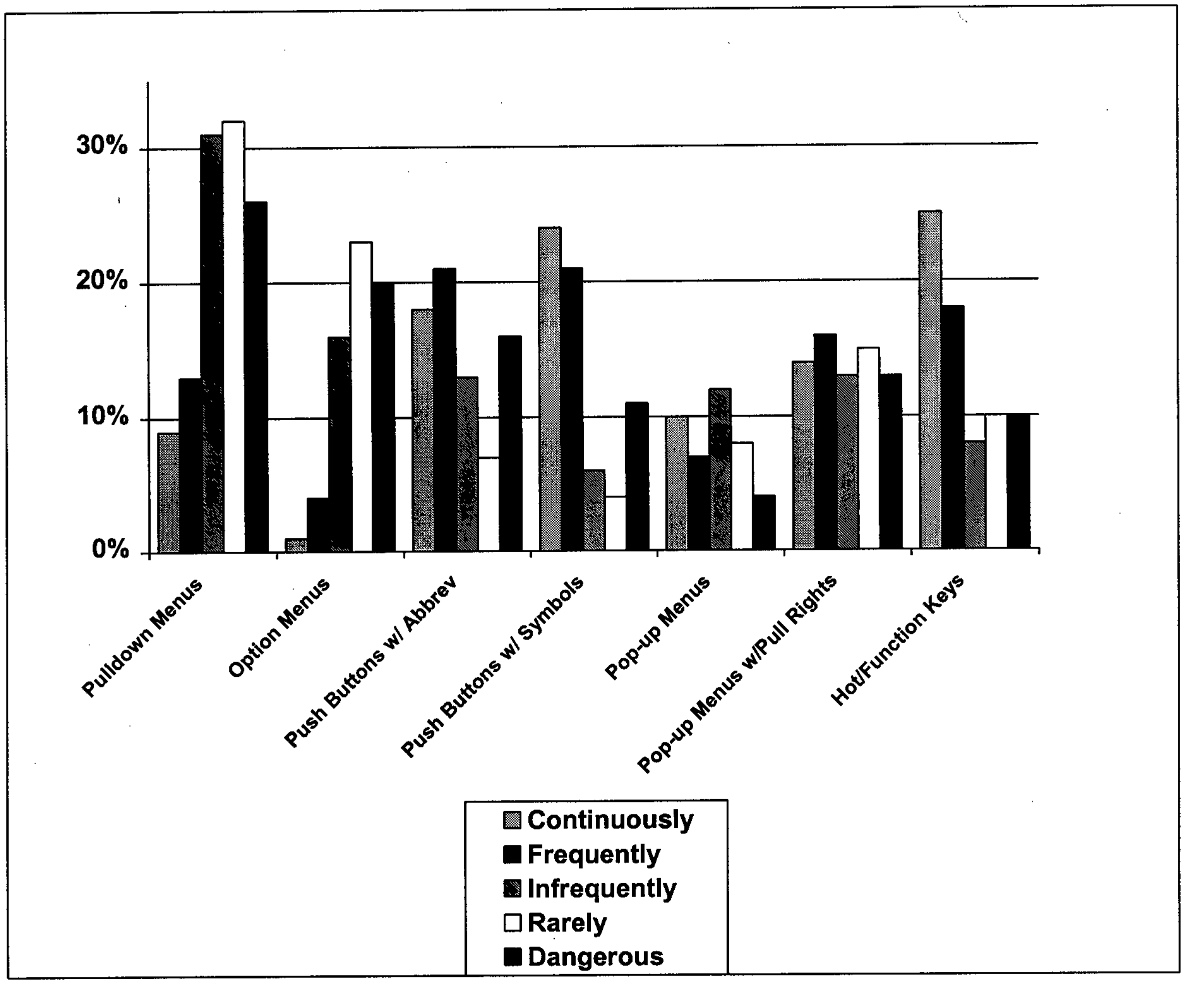


**Figure 5. Control Interface Options Preference By Type of Control**

preferences in frequency of use order were rarely performed (23%), dangerous to personnel or systems (20%), and infrequently performed functions (16%).

A push button control is a momentary control that immediately performs the action upon selection then returns to its non-status state. For push buttons with abbreviations or text as labels, the preferences in frequency of use order were frequently performed functions (21%), continuously performed (18%), and dangerous to personnel or systems (16%).

For push buttons with symbols as labels, preferences in frequency of use order were continuously performed (24%) and frequently performed (21%). Evaluators approved of use of symbols as opposed to reading text for labels, but there was some concern that if a symbol was not recognizable, there was no alternative to understanding the control. Thus, these two control types were very close in choice of preference.

Pop-up menus were the least favored type of control interface option. None of the individual categories resulted in more than a 12% acceptance for pop-up menus versus the other interface options offered.
All frequency of performance categories for the pop-up menus with the cascading pull-right option resulted in nearly equal acceptance, none of which exceeded 16%.

The cascading pull-right options allow a hierarchy to controls that are related in function.

Hot keys or function keys were preferred by evaluators for continuously performed functions. Their frequency of use order was continuously performed functions (25%) and frequently performed (18%).

Figure 5 shows the results of the Phase 2 Evaluation regarding the operator's preferences of control type versus frequency and importance of a task or function being performed.

Through this iterative evaluation process, control characteristics and navigation, display layout and color usage, and a common set of operator tools began to emerge. This commonality initiative would eventually be characterized in the USW Sonar Systems Control and Display Standards and Conventions document.

## Document Evolution

The development of a USW Sonar Systems Control and Display Standards and Conventions document resulted from part time efforts over a two-year period by the OCWG members. It was deemed necessary to limit the group's efforts to USW sonar systems because that was where the most common operator tasks overlapped. The other tactical aspects of USW missions begin to diverge at that point for the various communities. For example, surveillance systems and submarines differ in that they both need to detect quiet submerged contacts, but the submarine must avoid or engage those contacts depending on a safety-of-ship or wartime mission. The submarine and surface ship differ in their missions of stealth and offensive versus defensive postures. Therefore, it was determined that the sonar system or detection end of the USW system was where commonality efforts could make the largest impact.

These control and display standards and conventions were consolidated into a document to ensure that a common "look and feel" existed for operator interfaces throughout the USW sonar systems in the surface, subsurface, and surveillance communities. This document was written primarily for the designers and software engineers who are involved in the design and development process of the user interface for USW sonar systems.

According to Mayhew (1992), a common "look and feel" is accomplished when there is:

- Consistent location of information on the screens;
- Consistent syntax of commands in a common language;
- Similar execution of analogous operations in different applications;
- Consistent design of command names and abbreviations;
- Consistent grammatical form of error messages and instructions;
- Consistent design of captions and fields on forms and displays;
- Consistent dialog style for different functions; and
- Terminology consistent with the users' existing vocabulary.

The benefits to be gained from standardization include:

a. Increased user productivity;
b. Reduced training requirements when transferring between various types of platforms; and
c. Increased efficiency in application development.

The standards document addresses the following areas of OMI: user-computer interaction (such as control and display navigation and selection); windows and window management (including primary and secondary windows, dialog windows and window components and placement);

common display features (including a suggested USW primary window template, common tactical symbology, acoustic cursors, and display characteristics); controls (e.g. push buttons, radio buttons, check boxes, scroll bars, tabbed pages, text and list boxes, scales, etc.); information presentation (including textual information such as font type and size, common terminology, acronyms, and abbreviations; alerts presentation scheme); and information coding in the areas of color flashing, contrast, size, shape, and sound. The document can be found in electronic format along with other reports and information concerning the OCWG and the phased evaluations at the www.ocwg.uswinfo.com website.

The consensus of the OCWG members was that these control and display "look and feel" standards could be adopted and utilized by their individual USW sonar system communities.

## Practical Application of Document

Future USW Sonar Systems, and possibly upgrades to current operational sonar systems, will capitalize on hardware and software commonality with existing surface, subsurface, and surveillance systems, to support the OMI Commonality standards open architecture design utilizing Commercial-Off-The-Shelf (COTS) technology. Due to varying environmental conditions and equipment foot print restrictions aboard the various USW Sonar System platforms, no specific hardware configuration is recommended for use of the Control and Display Standards and Conventions. The only hardware assumptions deemed necessary for this document is the inclusion in the USW Sonar System of at least one high resolution monitor (minimum resolution of 1280 x 1024 pixels), a keyboard, and an input pointing device (e.g. trackball or mouse) for operator interaction. Software assumptions include a standard commercial interface for a windowing system and access to the user input devices preferably via an X-Window system and the OSF/Motif toolkit. Other windowing operating systems may not yield the same expected OMI "look and feel" as described in the S&C document. Clearly effort could be made to adopt other emerging user interfaces (e.g. Windows NT, etc.).

A recommended implementation approach for the USW Sonar Systems Control and Display Standards and Conventions document will be to invoke by citing it in USW Sonar System contracts. It will apply to all OMI covered by the contract to the extent specified in the contract. The organization soliciting the contract is expected to specify the types of software to which the S&C apply. If the S&C is invoked without such a statement of selective application, it will be understood to apply in its entirety to all deliverable software.

The S&C document is written such that mandatory standards are labeled with "shall". Recommended standards in the document are labeled with "should". Developers shall comply with mandatory standards unless an exception is needed to provide critical functionality within the application. An approved waiver is required to deviate from these standards and conventions. Waivers shall be submitted to the soliciting organization's program office as directed by the USW Executive Steering Group (ESG). Waivers and deviations shall be submitted in accordance with contractual requirements.

A checklist is provided in Appendix A of the document to be used as a reference aid to developers as they implement these specifications in their USW System applications. All mandatory requirements and recommended standards are concisely listed by section to easily verify OMI compliance with these USW Control and Display Standards and Conventions.

Because this document is a "living document", suggested changes to this S&C may be submitted by Government agencies and prospective and selected developers. Comments, recommendations, additions/deletions, and data beneficial to improvement of this document should be addressed to each community's respective program office.

## Benefits

There are two major areas where benefit is achieved through the development of commonality. The first more obvious benefit is improved operability, while a second less obvious area is in reducing development time and cost. Most major systems are broken up into several subsystems with similar but distinct functions. These functions are brought together through an integration process typically late in the development cycle. The responsible individuals and associated software developers for each function typically work independently and hand off their work to an integration team. As a result of this development process, there is a large opportunity for each function to have a different "look and feel" and a different mode of operation that must be learned and remembered when operators move between these functions. This is not to say that there are not any coordination efforts ongoing to prevent this situation, but today's schedules and budgets drive aggressive development cycles that minimize those opportunities. The greatest insight to operability issues is seen during the integration process when budget and schedule pressure allow for little change outside of "just making it work". An effective approach to controlling operability inconsistencies and the associated operational and training impacts is through a Controls & Displays Standards & Conventions. The Standard provides a framework that the developer will utilize from the start of software development insuring a common "look and feel" at the time of integration. The standard does not, and should not, impact the functional requirements and as such should be a living document throughout the development process. Properly developed standards and conventions that are adhered to can significantly improve the cohesiveness of the total system when the individual elements are brought together.

A second important area of benefit is in the actual schedule and cost of the development. Under the current acquisition methodology, the use of integrated products teams (IPTs) are a key element in product development. The integrated product team for control & display functions will typically consist of fleet, Navy program office, Navy technical agent, and the development contractor representation. In the early stages of new development, a significant amount of time and budget ends up being devoted to control and display methodology discussions before and during the establishments of the mission functional implementation requirements. Much of that can be avoided through the early preparation and enforcement of a Display and Control Standards and Conventions. This allows for earlier attention to the critical aspects of the workstation design. The sooner those requirements are established the sooner software development can proceed. In addition, the software developer has a framework to begin development and for prototyping concept and ideas while detailed implementation is being finalized. From the development perspective, a properly designed standard attempts to maximize its use of standard commercial graphical user interface control features, preventing costly and time consuming efforts being applied to the development of new graphical features. This allows the software designer to utilize existing commercial tools in the user interface and concentrate more effort on the implementation of the functional requirements. This type of development also lends itself to portability of software allowing for smoother transition during the inevitable technical insertion phases in system evolution.

Additionally, this initiative opened communications between the surveillance, surface, and subsurface communities and allowed for technical data exchange that had not occurred previously. Beyond control and display issues, potential sharing of signal processing techniques, data processing methodologies, and OMI tools were also identified for exchange.

## CONCLUSIONS

An appropriately designed display and control standards and conventions will not only improve interoperability, but would also streamline the system development process. The existence of a standards and conventions document allows the software developers a mechanism to begin implementation in a consistent and cohesive manner. If properly designed, it can also ease software portability and mitigate technology insertion risks through the use of standard commercial software practices and operator interface tools. By using these commercially based operator interface standards, operator familiarity with the tactical system will be enhanced.

In an optimum approach, the software constructs would be developed by the contractor early in the design process to facilitate a consistent and cost-effective software design approach (design once, use many).

The implementation of the standards will require some design flexibility to meet the needs of the various communities. The spirit of the standard can be maintained, even if the exact implementation cannot. Therefore, the OCWG S&C document contains mandatory implementation statements labeled with "shalls" and recommended standards indicated by "shoulds".

With the continuing efforts to move to a network centric environment, sharing data across platforms may become the normal mode of operation of the future. Network communication improvements will soon allow for observation and potentially interaction of remote resources. This would mean that surveillance, surface, and subsurface operators would be sharing the same tactical data in real-time, situational environments. Clearly, a common operator interface will help facilitate the rapid assimilation of the acoustic environment.

The implementation of the standard will need to be invoked in a phased approach to mitigate cost and schedule impacts to the various programs. As a necessity, the commonality initiative will be achieved over a period of time as new and upgraded systems replace legacy implementations. This can only happen if the perceived benefit is accepted for all communities.

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Helen J. Douglas is a Computer Scientist in the Submarine Sonar Department of the Naval Undersea Warfare Center in Newport, RI. She has been with NUWC for 14 years working in the area of sonar controls and displays applications and operator-machine interface (OMI). Former responsibilities included sonar control and display definition requirements for the AN/BSY-2 Combat System. Her most recent duties include responsibility for OMI Commonality for the Virginia Class attack submarine combat system and participation in an effort to promote OMI commonality across undersea warfare sonar system platforms in the subsurface, surface, and surveillance communities. She has authored the VA Class Submarine Controls and Displays Standards and Conventions (S&C) document which provides guidelines to standardize operator interface methodologies across 15 federated subsystems of the VA Class Submarine Combat System. Ms. Douglas also co-authored a similar standards document for the OMI Commonality Working Group (OCWG) that is being recommended for use in combat systems in the subsurface, surface, and surveillance communities. Through performance of the VA Class S&C checklist, which provides a measure of application commonality, she has had the opportunity to review various OMI designs. She has also conducted OMI evaluations with fleet operators across communities in support of the OCWG effort. She continues to work directly with fleet operators through OMI design reviews and addressing specific OMI related issues.

David Zannelli is a System Engineer in the Submarine Sonar Department of the Naval Undersea Warfare Center in Newport, RI. He has been with NUWC for 21years and has spent the last 17 years working in the area of Sonar Controls & Displays Applications and on the development of Workstation Hardware requirements. Former responsibilities included sonar controls and displays definition requirements for AN/BQQ-5 Sonar System and the AN/BSY-2 Combat System. His most recent duties include Controls and Displays lead for the Navy Integrated Development Product (IDP), which includes the A-RCI backfit program, as well as the Virginia Class Submarine. He has lead responsibility for the development of the COTS workstation replacement for the AN/BSY-2 Combat System and is also supporting the A-RCI enhanced workstation (ECDWS) console design and development. As technical manager of the Acoustic Display Research Facility (ADRF), a Submarine Sonar Department laboratory, he manages a team of engineers and computer scientists in support of workstation protoype development to establish controls & displays design requirements for current and future systems. In addition, technology insertion candidates, such as new operator-machine interface (OMI) devices and flat panel displays, are assessed for their applicability to combat system applications. He is a member of the OMI Commonality Working Group (OCWG) representing Submarine Sonar and supports the Concepts of Operation (CONOPS) OMI Working Group for Advanced Processor Builds in the transition of new integrated fleet products.